

Rocky Flats Plant

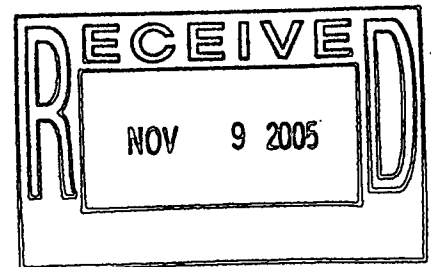
Ecological Monitoring Program

ANNUAL REPORT

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ADMIN RECORD

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soil chemical data, which were not available in time for this report. Differences among xeric sites were also detected for various species/element combinations.

The data from the second sampling session must still be analyzed and interpreted, and these results will be correlated with ecosystem function measurements, vegetation data, soil physical/chemical data, and soil invertebrate data. Plant tissue analysis in the coming season will focus more on determining ecosystem pools and the using a few selected species as bioindicators.

C) AQUATIC ECOLOGY

The aquatic ecosystems associated with the RFP range from natural springs and seeps, which generate temporary stream reaches that are upstream and uninfluenced by plant activities, to containment ponds engineered to hold "domestic" sewage outfall and accidental contaminant releases. The hydrology of streams and ponds at the RFP is highly regulated by both onsite activities and the needs of the ranchers whose water flows through plantsite. Subsequently both streamflow and pond elevation vary seasonally, following to some extent the natural hydrologic regime, and temporally, based on anthropogenic manipulation. Transport of contaminants via water to receptor ecosystems onsite, i.e., Woman Creek, and possible transport offsite is a major concern at the RFP.

The characterization of the structure and function of the aquatic ecosystems at the RFP is required before documentation of their response to natural versus anthropogenic perturbations is possible. Previous work at the RFP has attempted to characterize the aquatic ecosystems of RFP through assessment of specific endpoints such as macrobenthic species abundance and diversity. Uncoupled from their ecosystem context such measures provide limited information especially in regard to intersystem comparisons between selected "reference" ecosystems and contaminated "receptor" ecosystems. The EcMP is defining methodologies and identifying sample sites which can generate the kinds of information needed to address complex regulatory issues and aid in decisionmaking at the RFP in a scientifically defensible manner.

Selected spring, stream, and pond ecosystems were sampled during August and September, 1993. Ninety samples for water chemical analysis were collected from 25 sites. Biota samples included macrobenthos, zooplankton, phytoplankton, algae, periphyton, and emergent insects. Emergent insect samples had not been previously collected at the RFP. Forty-five samples of phytoplankton from 11 sites and 52 samples of zooplankton from 9 sites were collected. Thirty-six samples for quantitative macrobenthos from 8 sites and additional qualitative macrobenthos from 6 sites were collected. A total of 171 emergent insect samples were collected from 13 sites. In total, 277 samples of aquatic biota were collected during the first year of the EcMP. Water chemistry and or biotic samples were collected from ponds (A-1 through A-4, B-1 through B-5, C-1, C-2, D-1, and D-2, from Lindsay Pond, the South Interceptor Ditch and the OU11 Pond), springs (Antelope Springs, Antelope Springs North, and Lindsay Ranch Spring), and streams (Antelope Springs tributary of Woman Creek, Rock Creek, Smart Ditch, and Woman Creek).

Water chemistry results range from highly dilute, reflecting precipitation inputs, to very concentrated, reflecting evaporation in ponds with no outlets. Good agreement was found between our offsite laboratory and the 881 Laboratory measurements. Results from EcMP QA procedures discovered a methods problem which may result in a bias related to field filtering procedures and the determination of dissolved organic carbon concentrations. This problem is being evaluated and recommendations will be available soon.

Only limited interpretation of water chemistry and biotic sample results is presented in this report as we await the results of analysis of biological samples. Preliminary results presented here have documented the importance of habitat factors such as macrophyte communities, trophic conditions, and fish community structure on the major endpoints typically used to define aquatic ecosystem "health." The design of the EcMP Aquatic Ecology module at Rocky Flats will attempt to take these factors into account. Monitoring emergent groundwater chemistry and aquatic biota at seeps and springs could be an important feature to be added to the Aquatic Ecology module as well as the monitoring of paired temporary stream reaches from reference and potentially impacted sites. Sampling these systems will require the use of new sampling methods and sampling schedules appropriate to these ecosystems. EcMP will develop and use aquatic endpoints that are comparable between ecosystems. To more efficiently accomplish EcMP objectives and provide information to, and utilize valuable information from, other monitoring activities at the RFP, EcMP has begun co-sampling ponds with the Surface Water Division (SWD) and the Colorado Department of Health (CDH) using the assistance of the SWD contractor. This coordinated activity not only improves efficiency of field sampling, but also allows for a comparison of aquatic biota and water chemistry as measured following EcMP procedures, with chemical analysis done by SWD and CDH. The extensive water chemical evaluation for contaminants of concern provide for an analysis of the relationship between aquatic biota and contaminant concentrations that would otherwise be beyond the scope of the EcMP. There is also the opportunity to repeat a study of stream macrobenthos done 20 years ago at RFP to assess temporal changes in that community.

D) SMALL MAMMALS

The Small Mammal module report consists of three sections: small mammal capture, Longworth/Sherman trap comparison, and habitat characterization. Capture information is used for determining the diversity, abundance, and distribution of small mammals at the RFP. Small mammals were surveyed at the RFP because they can be good indicators of the presence of contaminants, that is, they occupy small home ranges, live in close contact with the soil, and have a variety of food sources. Additionally, they are a primary food source for predators. The trap comparison study was conducted to determine if one of the two trap types used during the study is superior to the other in terms of reliability and ability to capture a variety of species. Habitat characterization of successful and unsuccessful trap sites was conducted to determine habitat preferences of the RFP's small mammal populations. The primary objective of this study module is to assess the dynamics of small mammal populations at the RFP and the relationship of

these populations to specific habitat characteristics in order to determine if populations have been affected by plant RFP activities.

Small mammal trapping occurred in two sessions, April 28, 1993 to May 28, 1993, and from August 31, 1993 to September 16, 1993, following procedures presented in the EcMP Program Management/Technical Performance Report, 1993, Appendix 16. Nine terrestrial sites were sampled using Sherman live traps in the spring session, and 12 sites were sampled using Longworth live traps in the fall session for 300 trap-nights per site. Habitat data from successful and unsuccessful trap stations were collected and began as soon as information regarding trap station success was available. The first small mammal trapping exercise was conducted by END personnel. Two teams of subcontractor personnel conducted the second session, with oversight by EcMP personnel; two to four teams of two subcontractor personnel conducted the habitat characterization exercise for the second session, with oversight provided by EcMP personnel; and the trap comparison exercise was done by EcMP personnel. A total of 223 capture records were entered into the EcMP database for the spring session of small mammal trapping; 740 records were entered for the fall session of small mammal trapping and 235 records were entered for the Longworth/Sherman trap comparison. Habitat data were collected at 239 trap stations.

Longworth traps were superior to Sherman traps in their reliability (they were found closed but empty significantly less frequently than Sherman traps), and in their higher capture rates. The data indicate however, that larger and heavier species were more frequently captured by Sherman traps, which have larger openings, and that prior trap experience is important to some species. This study will be repeated in the spring and in the fall of the upcoming field season.

A previously undocumented species for the RFP, the Olive-backed Pocket Mouse (*Perognathus fasciatus*), was captured at a xeric grassland site. One Preble's Jumping Mouse (*Zapus hudsonius preblei*), a Colorado State species of special concern, was captured at a riparian site, extending the known range of the species onsite and in Colorado. As expected, the Deer Mouse (*Peromyscus maniculatus*) was the most common small mammal species on plantsite for both trapping sessions and in all community types. The highest populations of small mammals were found in riparian areas and the lowest populations were found in reclaimed areas. More captures of all species were recorded in the fall trapping session than in the spring. This is to be expected due to reproductive habits but may also be partially attributed to the different trap used in the fall. Longworth traps will be used in future EcMP studies.

Although the Habitat Characterization exercise was completed on time, the data have not been entered in the database. Field data sheets have been checked for inconsistencies and missing data and all detected problems have been resolved.

E) SOIL PHYSICAL/CHEMICAL CHARACTERIZATION

Although the interpretations of soil physical and chemical data are used by several disciplines, the EcMP is primarily concerned with properties related to ecological and biological endpoints. Soil data are especially important in terrestrial ecosystems because soil serves as a medium for plant growth and represents the major nutrient capital of a site.

Data measured in this module represent a fairly complete suite of physical and chemical data that have ecological applications. Physical/chemical data are best used in an integrated sense because they influence biotic endpoints. All sampling was collocated with several other layers of biotic information. This information can be correlated to variables in plant nutrient, terrestrial vegetation, soil invertebrate, ecosystem functions, and small mammal data modules.

Objectives of this module include: 1) the characterization of soil physical and chemical properties from the 12 permanent EcMP terrestrial sites, 2) the sampling of soils so that the above characterization can be related in space and time to other EcMP data modules, and 3) the determination of surface soil nutrient pools for different vegetation communities at the RFP.

Soil samples for physical/chemical analysis were collected from the 0-10 cm depth from 12 EcMP terrestrial sites (TR01-TR12) in the Buffer Zone and from 12 plots, 5 samples/plot in OU 11 during August and September, 1993. Seventy-five samples were taken from the 12 EcMP sites and 60 samples were taken from OU 11. Each sample was analyzed for the following parameters: particle size analysis, available soil water, pH, total carbon, total nitrogen, hydrogen, extractable macronutrients (5 elements), extractable micronutrients (4 elements), soluble nutrients (4 elements), cation exchange capacity, total element analysis (19 elements), carbonate, and bicarbonate.

Many of these endpoints are recommended under NRDA guidelines for evaluating damages to soil resources.

The soil physical/chemical database structure development is near completion. EcMP personnel will reduce, analyze, and interpret data to the greatest extent possible prior to the 1994 field season. It is anticipated that some analyses may be dropped and others added, and that sampling will continue to be collocated with other data modules in the EcMP program. EcMP personnel will test two or more field bulk density methods to allow conversion of site information to a community basis. Additionally, EcMP staff are working with Environmental Restoration to coordinate the location of proposed soil pits as part of the Sitewide Soil Survey. Where feasible, soil pits will be located near or within the boundaries of the permanent EcMP sites.

F) SOIL INVERTEBRATES

Soil invertebrates include several classes of organisms that are concentrated near the soil surface but may also exist at great depths in the soil profile. They range in size

from microns to centimeters in length, but most are barely visible to the human eye. Invertebrates are critical in the breakdown of litter and the subsequent recycling and storage of the nutrients in that litter. Since many invertebrates have soft bodies and are in intimate contact with soil particles and water films, they are often susceptible to chemical contaminants and physical perturbations. The number and kinds of invertebrates may thus respond to disturbances in ways that can be related to the disturbance agent. However, since there are no historical soil invertebrate data available for the RFP, initial data are needed to establish baseline conditions for several representative community types.

The objectives of this module are: 1) to characterize the taxa and functional groups of soil invertebrates from several terrestrial vegetation communities and determine sources of variation that affect seasonal, annual, and long-term changes in each community, 2) to determine if the RFP has a unique soil fauna when compared to other offsite areas, 3) to determine if soil faunal community structure can be correlated with other biological indices, such as ecosystem functional measurements and vegetation species composition, and 4) to identify potential indicator species sensitive to stressors of interest at RFP.

Soil samples for invertebrate analysis were easily collected with hand tools in the field. Samples were then transported to a laboratory, and three representative taxonomic groups were chosen for analysis: protozoa, arthropods, and nematodes. Arthropods and nematodes were dynamically extracted directly into preserving fluid and then counted and identified under a microscope. Protozoa were plated onto slides, identified, and counted. Organisms are also classified by functional group, such as predator, shredder, etc.

Soil invertebrate samples from 0-5 cm and 5-10 cm depths were collected from 12 EcMP terrestrial sites (TR01-TR12) in the Buffer Zone and from 12 plots, 5 samples/plot, in OU 11. Three hundred forty soil invertebrate samples were collected from the 12 EcMP sites, and 264 samples were collected from 12 OU 11 sites to support the Environmental Evaluation conducted there by END staff. Sampling took place from mid-August 1993 until the end of September. Samples were collected by EcMP staff and subcontractors. Due to contract delays, samples were only collected once during the growing season, so seasonal trends cannot be determined from 1993 data. All invertebrate samples were collected in conjunction with ecosystem function and soil physical and chemical samples.

All samples have currently been processed and extracted by the laboratory, and protozoa analysis is complete on all samples. Arthropod and nematode identification and quantification is underway, and data will be available for analysis prior to the 1994 field season. It is intended to model some database elements after those developed in the Terrestrial Vegetation module, such as a species library and a taxonomic dictionary; these elements are under development.

There are several areas in the current program which can be refined in 1994. Sampling intensity must be reviewed in light of variability encountered from 1993 data

sets, and multiple sampling periods will be considered. Offsite sampling areas will be selected to provide comparison areas to RFP sites. EcMP staff will also examine the possibility of performing sample extractions at RFP laboratories. This would lead to greater quality control in sample handling, faster processing times, and greater flexibility in field sampling. If soils can be extracted immediately following sampling, soil invertebrate analysis can be elevated to a real-time monitoring tool.

G) ECOSYSTEM FUNCTIONS

Ecosystems are defined as communities of organisms and the physical factors with which they interact. Ecosystem functions include energy and nutrient cycling, soil development, and organic matter transformations. Ecosystem functions are evaluated by measuring flows directly in the field, or by measuring pools of organic matter with the potential to flow in the laboratory. In this module a number of key nutrient pools and associated soil properties were measured in the laboratory. Carbon and nitrogen represent the largest material and energy flows in any ecosystem. These flows are facilitated to a very great extent by soil microorganisms in terrestrial sites. The soil microbial biomass usually constitutes the largest biomass after plants. Therefore, the soil's potential to sustain microbial biomass is an important delimiter of ecosystem function.

The objective of this module is to evaluate measurements of the concentrations and inherent variability in potential ecosystem-level functions as indicators of the ecosystem's well-being. Parameters associated with single individuals, populations, and communities were left to other modules. Particular emphasis was placed on indicators of nutrient cycling processes. These functional measurements, along with existing semi-arid grassland ecosystem data, will be used to track ecosystem-level parameters. The responses of these parameters to perturbations, either natural or anthropogenic, can only be evaluated in light of their normal variations in time and space. We believe that these ecosystem-level measurements, in conjunction with concurrent studies at other levels of biological organization, will greatly enhance our ability to interpret ecological patterns at RFP.

Onehundred fifty-one soil samples for Ecosystem Function parameters were taken from 24 field sites in August and September 1993. The 12 sites sampled for vegetation cover measurements were also sampled for ecosystem function parameters. Five transects were sampled within each site. Twelve additional sites from four replicate grids within each of the three treatments were sampled from OU 11. Ten sites were sampled for quality assurance purposes.

EG&G received the first laboratory data on January 5. Results will, when available, include a variety of nitrogen and carbon cycling parameters. Associated parameters needed to interpret these data will also be reported including fine particulate organic matter, a recently developed parameter that may prove to be well correlated with potential rate and flux measurements.

Ecosystem Function data will be examined to evaluate the differences between vegetation communities and to evaluate the inherent variability within a site. We will compare concentrations of organic carbon and nitrogen, the fraction of organic matter in microbial biomass, or in active forms. Community types will be statistically compared, as well as the three treatment areas from OU 11.

Future analyses rely on detailed evaluations of results obtained this year. Depending on the availability of suitable methods, respiration, dinitrogen fixation and denitrification may be measured directly in the field. If technical difficulties can be resolved, these types of measurements could provide estimates of flows to compare with the pool size information provided by the kinds of measurements made this year. We may also assess trends and variability over time and space in the future.

H) EcMP DATABASE

The EcMP Database has been designed and developed as a vehicle for entering, summarizing and storing data collected under the EcMP, as well as to provide the flexibility to export data into other software applications for statistical analyses and manipulation. The format for EcMP database files is dBASE IV. This software runs on IBM or IBM compatible PC's. Database files created in dBASE are fully compatible with Fox Pro for Windows, the new plant standard database software package, and may also be easily imported into spreadsheet programs (e.g., EXCEL), word processing programs (e.g., Word for Windows) and statistical software programs (e.g., Statgraphics).

All EcMP data entry screens have been developed using dBASE IV version 2.0. Each technical module contains a set of data fields which store the information for that module. A master list of all EcMP data field names and their definitions (including a list of the codes associated with them), is maintained by the EcMP database manager to avoid unnecessary duplication of data fields between technical modules. The structure of these data fields (logical, character or numeric field, and width of field) is also documented, to insure consistency among database files. The consistency of database design is necessary to allow database files to be linked between technical modules for analyses requiring the integration of many separate data sets.

Data sheets are subjected to detailed quality control to identify missing data, incorrect data, and inconsistencies prior to data entry. Copies of original field data sheets are used for data entry, allowing the data entry technician to annotate records as they are entered. Most chemical laboratory data are directly machine captured. Data entry from field data sheets is menu driven, so the user need not be familiar with dBASE IV to input data. The data entry screens prompt the user to enter data into the appropriate data fields, and have been designed to minimize keystrokes necessary for completing a record. Where global default values exist for a data field, they are input automatically. All records for permanent locations may be entered at one time, to avoid retyping the location data fields. Data which are not collected on field forms, but are required for summarizing or organizing raw data, are imported from other database files (e.g., species names, taxonomic groups, functional grouping of species, grouping of EcMP study sites by plant community type). Database files are backed up onto diskettes following each data entry

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